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You say I 'm a fool ;  
I grant, it is true ;  
For, if I were not,  
How could I love you ?

## III.

“ Montes, prados, flores, selvas,  
Consolad á un afligido ;  
Que de amores y desdichas  
Se mira todo abatido.”

Mountains, meadows, flowers, and forests,  
Cheer a youth in deep distress ;  
Who by love quite overpowered,  
Loses rest and happiness.

## IV.

“ Dicen algunos que son  
Los zelos de amor un hielo ;  
Mas en mí vienen á ser  
Materia que aumento el fuego.”

Some say that jealousy  
To love, is ice to fire ;  
To me it rather seems  
It makes the flame rise higher.

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ART. VIII. — *Letter from the Secretary of the Treasury, transmitting a Report of F. N. HASSLER, Superintendent of the Coast Survey, showing the Progress made therein up to the Present Time. Doc. No. 28. House of Representatives. Treasury Department. 27th Congress, 2nd Session.*

By this valuable communication, as well as by information reaching us from various sources, we are warned that the great public work of the Survey of the Coast is in danger of being again abandoned, or, what we should regard as still more unfortunate, of being superseded by some other plan of operations.

In a former Number\* we presented a concise view of the

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\* See *North American Review*, Vol. XLII. pp. 75 et seq.

nature of geodesical operations, and of the principles upon which they are based. The remarks there made upon the subject we conceived were sufficient to show the futility of any scheme for arriving at the perfect knowledge of any extensive portion of the earth's surface, for constructing a map, or correctly determining and connecting a number of distant situations, by any other rules of procedure than those which the science of Geodesia prescribes. They also afforded some data for a comparison between the American survey, as far as it had then proceeded, and similar works in Europe ; such as, whether applied to the progress or the character of the work, might well gratify national pride. Our present purpose is, to submit a few remarks, not of a character to interest the scientific reader, but designed rather to arrest the attention of men, who, being necessarily uninformed upon matters of strict science, are nevertheless called upon in their high places to exercise judgment, and exert authority, upon questions in which the highest science is involved. It is our present aim to secure a clear and impartial investigation ; to correct misrepresentations ; to counteract the designs of scheming speculators ; to defeat, if necessary, the instigations of ill-will ; and to uphold the scientific reputation of the country, which is in some measure dependent upon the successful prosecution of this great national undertaking.

The question first in importance with regard to the coast survey is, whether any other mode can be adopted ; — this mode having for its object the greatest amount of useful information, in the shortest time, and at the least expense. In discussing this question, so much has been said, and is still urged, concerning the use of chronometers, and the substitution of them for the present system of triangulation, that it seems worth while to say a word upon this subject, premising, that the serious consideration we here give to it does not arise from any idea of the value attached to such a suggestion in the minds of scientific men.

The chronometer in the hands of modern artists has, it is true, attained a degree of excellence which admirably adapts it to the general purposes of navigation, and supplies to seamen the most useful means of solving the problem of longitude. Still it is far too imperfect an instrument to be relied on implicitly. It possesses an inherent and constant liability to error, and although its accuracy may be preserved through

any short period, this liability is so multiplied by time, and the chances of accident, as to deprive even those which are most carefully constructed of all claim to perfect confidence. In cases where their use is indispensable, as in detached and local surveys, in the cursory examination of distant and inhospitable regions, or in carrying a chain of longitudes around the globe, and generally where strict and careful measurement is for any reason forbidden, their imperfection is in some measure remedied by numbers. Acting as checks upon each other, the amount of error is reduced, and the observer is enabled to fix, with a degree of precision sufficient for the security of ordinary navigation, the simple position of certain points and headlands. This, however, is regarded only as the palliation of an evil; the evil itself is fundamental, and admits of no complete remedy.

In determining differences of time between meridians widely separated, chronometers have sometimes proved remarkably successful, and have exhibited results of surprising accuracy. The reverse of this proves to be the case in the adjustment of minor differences, where the essential defects of the instrument are particularly displayed. There is no space, however small, of perceptible magnitude, which may not be submitted to trigonometrical measurement; but it will be readily understood, that there are points, at minute distances asunder, between which no difference of local time can be estimated. If it be asserted, which we are by no means prepared to admit, that such distances are unimportant in a geographical view, it will appear that they are of the highest topographical value when we come to consider the character of our southern coast.

If chronometers, however, could be implicitly relied on, and the determination of longitudes by means of them admitted of greater exactness, still it is to be borne in mind that their use, in connexion with the sextant, goes so far only, as to decide a certain number of fixed points.

This cannot in any strictness of language be called a *survey*. It still remains to fill up the intermediate spaces by some sort of measurement, and the mode and result of this operation are questions of serious importance. We need not enter into any detail to show, that a survey of this kind must content itself with the bare outline of coast, harbours, islands, &c., neglecting all the valuable details belonging to

physical and statistical geography, differences of level, and the distribution, limits, and peculiarities of the country under inspection, all of which are included in the operations of a geodesical survey.

We are told, that despatch is one of the recommendations of the chronometric plan. Numerous parties will probably, therefore, be immediately employed, and it will remain afterwards to harmonize their labors by joining the distant points of observation. To do this will, we conceive, be no easy task ; and, if such a plan be adopted, we shall not be astonished to learn hereafter, that the attempted meeting of these unconnected operations is likely to break up in the most admired disorder.

We do not mean, in any thing we have said, to underrate the value of chronometers in their legitimate sphere. They might, undoubtedly, be advantageously employed in the preliminary determination of important points on the coast, which are known to be erroneously laid down.

Their accuracy may be depended upon within a mile, and even this imperfect knowledge will be in some degree a relief to navigators, where errors of alarming and uncertain magnitude are known to exist in their charts. Mr. Hassler has, in his letter to Mr. Gallatin, given to this proposition all the consideration it merits.\* If such occasional use should be made of them, and the present system of survey should be continued, subsequent comparisons will abundantly prove, that even the simple determination of geographical positions by chronometers (omitting all question of a connected survey), however skilfully and expensively conducted, is unavoidably defective.

In a matter that may be subjected to rigid mathematical investigation, results are anticipated, and conclusions distinctly enunciated. But perhaps it will enforce our argument to exhibit some facts, that have immediate relation to the present inquiry. We select such as are nearest at hand. An attempt was made to determine the place of the Capitol, by means of chronometers, by Mr. Paine of Massachusetts, a gentleman distinguished for his zeal and ability in these calculations. He carried three chronometers from Boston to Washington, through Philadelphia, and back, observing the difference of

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\* *American Philosophical Transactions*, New Series. Vol. II. pp. 238, 239.

meridians of the three cities, both going and returning. The results of these are spoken of as important. The difference of his two longitudes of Washington, by Philadelphia and by Boston, is 14."25. The difference between the mean of his observations, and the adopted longitude of Washington is 12."9; whilst Mr. Paine's longitude of Washington differs from the mean of seven results of astronomical observations, solar eclipses, and occultations, by 41."4.\*

In the trigonometrical survey of the State of Massachusetts, begun in 1831, and concluded about a year since, embracing a territory of 8230 square miles, we find an exemplification of our argument at once pertinent and conclusive.

A letter from Mr. Simeon Borden, the superintendent of this survey, to the American Philosophical Society, in addition to an account of the work, gives a "comparison of his own results with those obtained by Robert Treat Paine, Esquire, from observations with a Troughton's sextant and mercurial horizon, and chronometers transported to different stations."

In the longitude of Pittsfield the chronometers exhibit a difference of 28."98, — nearly one half of a mile; yet thirty-nine chronometers were used in thirteen journeys. The meridians of Cambridge and Dedham are 3.'30."43 apart by trigonometrical measurement; the chronometers give the difference of longitude 3.'11."10, making an error of 19."33. In the case of Cambridge, twenty chronometers were used in six journeys, and in that of Dedham twenty-three chronometers in seven journeys. Gloucester and Plymouth, both seaport towns, which ought therefore to be known correctly, coincide in longitude, within 2."10. The chronometers have increased that difference to 8."55. This instance illustrates what we have before said of the incapacity of chronometers to note minute differences of local time with the requisite accuracy.

Williamstown, where twenty-eight chronometers were employed in ten journeys, is placed 19."24 to the west of its true position. We have already remarked, that Pittsfield is 28."98 in error. The sum of these two variations is 48."22, or eight tenths of a mile, and one third nearly of the difference of longitude of the two places.

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\* *Determination of the Longitude of several Stations, &c.* reported by Sears C. Walker. See *American Philosophical Transactions*, Vol. VI. p. 265, note.

The longitudes of Williamstown and Dedham, as decided by the chronometric method, present a discrepancy of  $29''.32$ , or one half a mile nearly ; fifty-one chronometers, in seventeen journeys, were used to fix the position of these two towns. Other instances might be added to this list, but the table of comparative *latitudes* demands a passing notice.

The determination of this element, as is well known, is much less liable to error. A combined difference of  $9''.86$ , or one sixth of a mile, appears in the latitudes of Boston and Squam Light ; and here the industry of Mr. Paine accumulated no less than four hundred and eighty altitudes for the determination of these two places. Three hundred and ten altitudes place Amherst  $8''.70$  south of Cambridge ; but an error of  $4''.80$ , more than one half of the difference of latitude, is proved in these observations by Mr. Borden's measurement.

The two greatest errors in this table are  $7''.30$  and  $7''.81$ , the sum of which makes the possibility of error amount to  $15''.11$ , or one quarter of a mile.

We will add one more case. Mr. W. C. Bond, the distinguished astronomer of Harvard College, whose remarkable accuracy and skill in the use of instruments, place him by the side of the best European observers, says, in a paper now before us ; " In June, 1839, I had observations with a transit circle, the illuminated end of the axis east and west, on the 16th, 17th, 20th, 21st, 23d, 24th, and 25th. These observations gave for the latitude of the instrument,  $42^{\circ}.19'.16''.9$ ." Reduced by the measurement of Mr. Borden, they determine the latitude of the State House, in Boston, to be  $42^{\circ}.21'.30''.3$ ". Mr. Paine's observations with the sextant and artificial horizon give  $42^{\circ}.21'.22''.7$ ". Four hundred and forty-two altitudes were taken by Mr. Paine, yet these insufficient instruments, in the hands of one perfectly skilled in their use, and guarded as far as possible against error by multiplied observations, fall short of the truth  $7''.6$ . Mr. Borden's latitude of the State House differs three tenths of a second from that of Mr. Bond's.\* The comparison of the precision of the two methods afforded by the Massachusetts survey is highly favorable to sextants and chronometers. It would be too tedious and expensive to apply to a great ex-

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\* *Proceedings of the American Philosophical Society*, May and June, 1841.

tent of territory, including a large and indented seacoast, the reiterated and laborious processes of Mr. Paine.

The survey of a portion of the earth's surface is a work which comes within the domain of the mathematics ; it may safely be said, that any determination of a place, in which the mathematical theory is disregarded, must be fundamentally defective. A reference to this theory brings us to an argument which, we trust, no misapprehended views of science, and no preconceived notions of utility or expediency, will overlook.

The system of triangulation, conducted upon the principles in physics which direct this department of science, takes into consideration the spheroidal form of the earth, and enables the surveyor to construct such a map of that portion of the spheroid which is comprised in his labors, as will be an exact representation of its real figure. This mode of surveying, and this only, regards the earth as it actually is, in its irregularly elliptical form, delineates its surface correctly, and treats of the true measure and configuration of the planet on which we live. Topography, and many of the details of physical geography, come within its province ; as the courses of rivers, the direction and elevation of mountain ridges, the nature of the land, &c. ; — knowledge, which is essential to the defence of the coast, to the construction of fortifications, and to all the duties of the military engineer. It furnishes the most accurate and convenient bases, from which a network of triangles may be thrown over any of the States through which it has passed. Some of them have already united their local operations with the general survey, to their great advantage. We may add, finally, in relation to this topic, that, when we are called upon hereafter to make our contributions to the common treasury of similar knowledge, this work will supply the requisite data for the measurement of degrees on the earth's surface, and for the "accurate determination of the elements of the terrestrial spheroid."

It promises, also, to be of especial value in giving future security to the intricate navigation of the southern shores, a part of the coast of the United States rendered particularly dangerous by numberless reefs, shoals, and sand-spits. It is well known, that these are variable in their limits and condition, gradually forming in some places, and in others changing their extent and direction, under the influ-



ence of violent winds and strong currents. In order to acquire a permanent and useful knowledge of their character, and to provide an accumulation of facts that will lead to an understanding of their probable formations, dispersions, and changes, a certain knowledge of their present state is indispensable beyond that which can be reached by sextants and chronometers. Rigorous observations upon these and similar subjects in Europe, by geologists and other men of science, have resulted in great benefits to navigation.

The increasing commerce at the south, the future establishment of naval stations there, and the close and hazardous sailing that must be pursued, both by merchant vessels and men-of-war, in the event of foreign aggression, make it desirable that the *in-shore* navigation of the southern coast should be well understood.

We have already shown what degree of reliance may be placed upon the chronometer under favorable circumstances and in skilful hands. We are justified, we believe, in saying, that longitudes by chronometers cannot generally be relied upon, as correct within less than one mile. But shoals of light and unstable sand, beaches widening and narrowing, and downs accumulating and dispersing, under the action of local and general causes, demand accurate measurements of feet and inches, by means of which the operations of nature may be carefully studied, future obstructions be prevented, present ones be removed, if possible, and an effectual security be given to the pilotage of the southern coast. A trigonometrical survey, made with all the fidelity that the improved state of the science insures, is the only method adapted to the attainment of all these desirable objects.

Some complaint has been made against the Superintendent of the Coast Survey, because its results have not been published from time to time as they have been determined. The power and duty to direct both the manner and the time of their publication rests with Congress, and to that body such a complaint may be appropriately referred. A full and sufficient reply to this charge is contained in the Report. We may add here, however, for general information, that engravers are now employed upon the first sheets, which will probably be issued in the course of the coming summer ; and, if the work is continued, the publication will hereafter take place regularly, as the plates come from the hands of the en-

gravers. When these charts, executed with precision and elegance, under the sanction of public authority, are produced, we shall, for the first time, be able to look upon similar works, contributed by the English and French governments to the safety of commerce and navigation, without envy and shame.

Much is said of the expense of the survey, as at present conducted. In this matter, we are not particularly careful to answer. An honest and prudent appropriation of the public money we are willing to leave in the hands of those to whom it is legally intrusted. In this case, at least, we may be contented to confide in their integrity. Economy, it is true, is a virtue ; but mere saving is not always economy, — it may be the most imprudent waste ; — and, being satisfied of the paramount importance of this work, both to the public interest and to the national honor, we might say, without further comment, that it should not be interrupted. It is in accordance, however, with our previous remarks to add, that this is one of those cases in which economy is not identical with retrenchment. If chronometers possess in themselves an insurmountable tendency to error, the survey undertaken by their means, and dependent on their results, is not likely to be ever completed. What is certain to-day may be doubtful to-morrow. Subsequent observations may bring discredit upon those which have gone before ; and it is to be apprehended, that, however multiplied they may be, so far from ultimately removing the difficulty, they will only serve to strengthen doubt, and increase perplexity.

Besides this, experience will prove that the repeated transportation of numerous chronometers will be attended with but little less expense than a regular and scientific survey. As some ground for this opinion, we shall refer again to the high authority of Mr. Paine. In a letter to the *Bureau des Longitudes* at Paris, he gives the longitudes of several towns in Massachusetts, the results of his own observations, and adds ;

“ These longitudes have been generally determined by the transportation of time repeated several times with numerous chronometers. Thus, between Northampton and Boston, I have carried seventy-four chronometers in twenty-four journeys ; between Amherst (the college) and Boston, or Northampton, twenty-seven chronometers in nine journeys ; between Barnstable and Boston, fifty-nine chronometers in six-

teen journeys ; and between Gloucester and Boston, sixty chronometers in sixteen journeys." \*

We have here an example of the manner in which chronometers are employed in the hands of a skilful observer. In estimating their use for a survey of the coast, the additional risk of transportation by sea is to be added to this account.

The financial department of the Coast Survey does not however present any thing so startling as to render these statements necessary for its defence. They are in themselves valuable facts and considerations, tending immediately to elucidate the subject, and weighing heavily against the proposed change ; but they are not, we imagine, essential to vindicate the present plan of operations from a suspicion of waste and extravagance.

Since the year 1832, six hundred and twenty thousand dollars have been appropriated to this service, one hundred and twenty thousand dollars of which remains on hand in the form of vessels, instruments, and other property, leaving a balance of five hundred thousand dollars to be charged to the survey. When we consider that this expenditure extends through a period of ten years, that it has been bestowed upon a great national work, of the highest importance to the commerce and defence of the country, that it is a contribution to knowledge, and that its investment in this way has gone further than any thing yet done, to establish the character of the country abroad for a liberal patronage of science, we are not disposed to regard it as an expense which the strictest economist may not approve.

As to the amount of money, and probable length of time required to complete the survey, we cannot do better than to say, that these questions are ably and properly treated in the document before us. " With the advancement of the mathematical and physical sciences, the means of acceleration of any work grounded upon them also increase. All that is needed is, that the whole work be carried on in the most economical manner." (p. 11.) We are satisfied, that its progress will compare favorably with that of any similar work

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\* *Connaissance des Temps*, 1843. Additions, p. 95. The *Additions et Corrections sur les Tables des Positions Géographiques*, by Mr. Daussy, will repay a critical examination.

in Europe ; and we are not willing to be behind the old world in accuracy, and in honorable and permanently useful results.

The course pursued has already met the approbation of men abroad eminent in science, and practised in such works, whilst at home the survey has more than repaid the sums drawn from the treasury by the benefits it has conferred upon two of the largest commercial cities, New York and Philadelphia. It ought to be a sufficient argument for its continuance, that it has discovered what other operations, though often repeated, failed to find out ; and its success here was owing to strict conformity to the principles of surveying, which alone a severe science recognises. It is needless to say, that the duration of the work is indefinitely protracted by the frequent interruptions to which it has been subjected. If it were permitted to enjoy the friendly and intelligent patronage of Congress and the government, the greatest number admissible of assistants would be employed, and all the rapidity of execution consistent with accuracy would be secured. Mr. Hassler has given a list of similar works which have been executed, and are now in progress, in Europe ; from which it appears that not only flourishing kingdoms, but even petty principalities, have made their triangulations. When we contemplate the wealth, extent, and dignity of this vast empire, we feel that the hope is not unreasonable which looks for enterprises suited to its condition. But science, which knows no limits either of power or national boundary, finds a home among the thrones and insignificant dominations of Italy and Germany ; and, if it be rejected from the councils of this nation, will confer upon their humble princes a distinction before which we must be content to bow. The abandonment of this work will not fail to be regarded in Europe both as a calamity and a dishonor. The impress of instability, which seems to be stamped upon every public measure, might at least be removed from this, in which all parties and all prejudices may unite and harmonize. The survey of the coast has already created a distinguished school of topographical and hydrographical engineers, thus overcoming one of the early difficulties in the undertaking ; it will further contribute to erect a standard of science, the practical value of which we cannot now discuss. Should some other mode be adopted for the time, there can be small doubt that the pres-

ent method, the only one which strict science approves, will be hereafter resumed ; and “ the chances of an accumulation of errors upon such a long extent of seacoast as that of the United States, particularly in the direction in which it lies, will be too great, and the consequences of a want of system and care too glaring, not to bring discredit and shame upon a less accurate operation.” \*

We observe, in conclusion, that we have heard with surprise, that some officers of the navy are to be found among the active enemies of the present survey of the coast. It certainly reflects no credit upon that gallant profession, that such should be the case. None are so likely as seafaring men to profit by its labors, and we were disposed to believe, that gentlemen of that service were able to appreciate the utility and merits of the work. We will venture to remark, that it will give a desirable appearance of candor and disinterestedness to their efforts, if they are not found to derive a personal advantage from any contemplated change of measures which may go into effect. If, among those who are consulted either by the Navy Department or by members of Congress in relation to this subject, there be found any who have heretofore unsuccessfully sought a connexion with the Coast Survey, or who, having been once engaged in it, have had that connexion unhappily dissolved, it will be well, in considering their testimony, to weigh its value with an even hand. Any suspicion that may rest upon their opinions will not be attributed to our suggestion, but to the common experience of mankind, and to that judgment of human affairs, which finds in the probable motives of men the best explanation of their conduct.

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\* *Papers relating to the Survey of the Coast. American Philosophical Transactions, New Series. Vol. II. p. 400.*

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